

Advanced Technology Microwave Sounder (ATMS) Assessment Report for Suomi National Polar-orbiting Partnership (SNPP) Sounder Science Investigator-led Processing System (SIPS) Data Level 1

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Data Product Version 2.0
Software Version 2.5

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1. Introduction

This document describes the assessment of Version 2 of Suomi NPP ATMS Level 1B Brightness Temperature V2 product (SNPPATMSL1B V2), available at NASA GDAAC. Version 2 products were created and released in March 2018 and replaced the previous Version 1 products, released in April 2017. The Version 2 software fixes an error in the quadratic correction, which was found after the release of Version 1. It also introduces a new channel dependent error characteristic for lunar intrusions.

The purpose of this document is to explain the updates for Version 2 software with respect to Version 1, and assess the resulting impact on the calibrated brightness temperatures. The focus here is on comparisons with the data processed by NOAA using the Interface Data Processing Segment (IDPS), called IDPS TDR from here on, which is available on NOAA Comprehensive Large Array-data Stewardship System (CLASS). NOAA has hereby a different focus than NASA: NOAA's main focus is weather prediction models and therefore reprocessing data is not a priority. Once an update is made, the forward processing stream continues with the software update.

NASA's focus is on continuity and reliability of long-term records. Maintenance and reprocessing are therefore mandatory. This report is referring to the updated NASA Version 2 Level 1 (L1) products. These products are the official NASA SNPP ATMS products that are produced by the SNPP Sounder SIPS.

As a result of this update the temperatures in the new NASA Version 2 Level 1 products are deviating more from the official NOAA IDPS TDR products than they did from Version 1. We will clarify the reasons for the deviations in this report. It should be noted that these deviations from NOAA IDPS could be confusing to the user, because they are varying within the timeline of the SNPP mission. This is the result of the different approaches with respect to data handling and production: NOAA changes affect data from the time of implementation, whereas NASA reprocesses the entire data since launch for major updates. The IDPS processing code was changed significantly in March 2017, whereas SNPPATMSL1B V2 is released in 2018. NASA V2 has therefore better continuity with respect to older records and we consider it the better option with respect to long-term observations.

To clarify the different approaches, we will first give a short overview of the NASA approach with respect to ATMS data and how it differs from the NOAA IDPS approach. This will be followed by a list of changes in the SNPPATMSL1B V2 and major changes in the IDPS.

The rest of this report will focus on quantitative descriptions of the changes in SNPPATMSL1B V2. We will focus on the comparison of the datasets, NASA's SNPPATMSL1B (V1 and V2) and IDPS TDR. We will do this for different timeframes of the mission to quantify and assess the impact of the different approaches. We hope to clarify the reasons why NOAA IDPS and NASA V2 differ over time in the record. The

rest of the report describes further the updates for the lunar-intrusion angles, followed by a short summary and an appendix that shows all channels for better comparison.

1.1 NASA's Approach for ATMS L1

The goal of NASA with respect to Earth observations is to have highly reliable long-term satellite L1 data records with minimal uncertainties and reliable and reproducible error correction. This requires control over all processing steps like calibration, error characterization and product maintenance. The development of NOAA products, however, which are available at NOAA CLASS, is focused on short-term operational applications. NOAA products are therefore less useful in long-term stability or retrospective error correction important for climate research applications. For this and other reasons NASA decided to create its own, independent ATMS Level 1 product, which can be created, updated and maintained separately from NOAA's IDPS TDR product.

The creation of a parallel and independent algorithm and product gives several advantages:

- More control over calibration procedures and uncertainties.
- The ability for retrospective reprocessing to allow continuity of the ATMS datasets.
- More control with respect to similarity and continuity: this means continuity with older datasets, but also with future microwave products, like those from current and JPSS satellites.
- The option for addendums of important information in the data files, like moon angle or land fraction.
- The creation of a L1A dataset that includes radiometric counts before calibration, which is helpful for error and calibration analysis.

Similar to the original NOAA product, the NASA product is based on the binary telemetric packages from Suomi NPP and the product is created almost in real-time. However, the conversion and calibration algorithms were developed and maintained by the SNPP Sounding science team in collaboration with the SNPP Sounder SIPS at JPL and maintained independently from the NOAA IDPS algorithms.

The difference in the products with respect to brightness temperatures is small: NASA and NOAA follow the same basic calibration procedure for microwave instruments. A detailed description of the current NASA calibration procedure and conversion can be found in the ATMS ATBD [1]. The IDPS algorithm was implemented before launch of SNPP, whereas the production and release of the Version 1 of NASA ATMS L1 began in 2017. The goal of SNPPATMSL1B V1 was to create similar brightness temperatures as IDPS TDR and minimize the deviation between the two products, as proof of correct implementation. The goal for subsequent versions of the NASA L1b algorithm is to implement improvements, which could lead to relatively substantial difference between

the two product streams. SNPPATMSL1B V1 therefore deviates from IDPS TDR mainly with respect to format and variables:

- The NASA product is created in netCDF.
- The file granule size is different from NOAA and similar to other NASA products.
- It includes a variety of additional variables from both L0 and L1, such as moon angle and error characteristics. This allows better data filtering, error estimates and also conformity with other NASA microwave products.

The new SNPPATMSL1B V2 has updates compared to V1: It therefore differs from IDPS TDR not only with respect to formatting and variables, but also with respect to brightness temperatures: An error in the quadratic correction factors was found and the calibration needed to be updated for SNPPATMSL1B. NASA created a new Version 2 and reprocessed all data for the entire mission. The IDPS code was corrected in a similar way, but the update to this IDPS TDR was made “on the fly” in March 2017 without correction of the earlier record. As explained before, one of the main reasons for NASA to create its own ATMS L1 product is the possibility of reprocessing. So, this difference in data handling created a confusing difference between the two datasets, which we try to explain in the following.

1.2 Changes in NASA L1 Version 2

As mentioned before, NASA Version 1 was created after launch, with the goal to be as close as possible to IDPS TDR. The code was tested in 2016 and compared to IDPS TDR. The agreement with IDPS was verified during the tests and this assessment will discuss these results in combination with this V2 assessment. After the test phase the entire ATMS mission since 2011 was processed until the current date. This Version 1 was made available at GES-DISC in April 2017 and incoming new ATMS data is processed with this code to ensure continuity.

However, the detection of an error in the quadratic coefficients warranted an update, because this error was affecting the brightness temperature results significantly. The processing code was therefore updated and tested. Results from the corrected code were compared to V1 and IDPS TDR and the changes were verified. The release of updated SNPPATMSL1B V2 products for the entire mission since 2011 at GES-DISC will be done in 2018. The new updated code will replace the previous V1 for future incoming real-time data. V2 has two major improvements compared to the previous version:

- Errors in the calibration coefficients were found in 2017, which were affecting both the NASA and the NOAA IDPS algorithms. These were corrected.
- NASA is producing an error flag indicating lunar contamination of the space view. Version 1 had a single threshold of 4 degrees for all channels. An analysis of the data found this insufficient and a channel dependent approach was developed instead.

The lunar contamination flag is only a small change compared to Version 1, and it is mainly improving the error flagging of lunar intrusions.

The error in calibration coefficients has a bigger impact: it changes the quadratic correction (see ATBD for details) and the resulting effect can be as great as 1K. This error is based on a misreading of the pre-launch calibration data and therefore affects the entire mission since the launch in 2011. This necessitated correction and reprocessing to ensure continuity of the data, resulting in a Version 2.

The IDPS TDR code was changed "on-the-fly" during the mission in March 2017, which has introduced a discontinuity into the data. Moreover, the IDPS calibration code was additionally changed over the course of the mission, resulting in further discontinuity and deviation from the NASA product. To understand the following assessment and differences between NASA and IDPS products, it is therefore important to understand the timeline of changes in the IDPS code.

1.3 Major IDPS Changes in March 2017

With respect to ATMS, there were several minor and 2 major changes in the IDPS code since launch 2011. This is affecting the continuity of the IDPS TDR product, which is available at NOAA CLASS. We do not want to discuss every change in the IDPS code, but only the ones that have major impacts on our comparison: So, we will only focus on the 2 major changes, which are marked as DR7954 and DR7966 in the IDPS documentation:

- Correction of the erroneous coefficients
- Changes in the calibration procedure of ATMS: it is now done with a radiance conversion, not with brightness temperatures

The implementation of the changes in the source code and the impact on the product are hereby different: According to the documentation of the IDPS code, source code was changed on May 28th 2015 and released with version Mx8.8.

But the implementation into L1 processing happened later. According to our comparisons, the available IDPS TDR data from NOAA CLASS shows no change before March 2017. However, obviously the IDPS code for the processing of ATMS L1 data was updated around March 8th 2017 and looks like both updates (DR7954 and DR 7966) were implemented at the same time.

However, with respect to continuity of IDPS TDR data from NOAA CLASS, this means two changes at once:

- The IDPS data before this date was calculated with erroneous coefficients, similar to the NASA Version 1. IDPS data before this date is therefore comparable to Version 1, IDPS data after this date is more comparable to NASA Version 2.
- The calibration procedure is now in radiance space and this is a major change in the way IDPS calculates brightness temperatures: The original coefficients do not apply anymore, specific radiance coefficients had to be calculated for the IDPS

code. However, the end product of IDPS TDR is still in units of brightness temperatures, which allows a direct comparison with the NASA product.

NASA decided to stay for now with the calibration in brightness temperature space until NOAA's IDPS change has been fully evaluated. The IDPS change results therefore in a deviation, which will be discussed in the assessment section. The discussion about advantages and disadvantages of calibration in brightness temperature or radiance space is not part of this assessment. It is sufficient to understand, that it needed to be assessed.

2. Assessment

This assessment is mainly focusing on the changes in Sounder SIPS Version 2 and their impact in comparison to IDPS software. However, to clarify the reasons in differences between NOAA and NASA products, we will sometimes refer to the obsolete NASA Version 1 for a better understanding. Based on the discussion above, it is therefore important to note that we take into account the date, when we compare a series of different datasets in this assessment.

For the NASA dataset, we have NASA Sounder SIPS ATMS-V1 and -V2, denoting Version 1 and 2. Both datasets are available from launch to the current date. For the NOAA IDPS dataset, we will define the data according to the changes: IDPS-oldCoeff, IDPS-newCoeff, IDPS-radbased (radiance-based).

Please note again: that IDPS does not do reprocessing. This means IDPS-oldCoeff is available from launch to 08-MAR-2017, IDPS-newCoeff/radbased from 08-MAR-2017 to the current date. In principle, IDPS-newCoeff and IDPS-radbased are the same, when it comes to the official product. However, we acquired the IDPS code for additional testing and can discriminate between IDPS-newCoeff and IDPS-radbased for further analysis. The reasons will become clear, when looking at the comparisons.

2.1 Statistical Comparison of Collocated Brightness Temperatures

The best way to understand the differences between Sounder SIPS ATMS-V2 and IDPS is by looking on the differences over the timeline of the current mission. The following paragraph will therefore focus on the statistical difference between collocated IDPS and NASA data for a range of selected days of the mission. Figure 1 shows the difference in Sounder SIPS ATMS-V2 and IDPS for the same day (March 20th) for different years. The results are shown for Channel 5, further channels are available in the Appendix. The crux between “reprocessed” NASA data and “on the fly”-changes in IDPS becomes obvious: An almost perfect alignment is visible in 2017 with a slight Gaussian variance. Older years show a deviation of 0.25-0.5 K and a strong deviation from Gaussian. The reason is obvious, when looking on the date of changes in NOAA's IDPS: IDPS data before 2017 is marked as IDPS-oldCoeff, when IDPS was using erroneous coefficients. IDPS data in 2017 refers to IDPS-newCoeff, when the updated coefficients were used,

resulting in a slight discontinuity of the data. Sounder SIPS ATMS-V2 does not have this problem of discontinuity: The data is reprocessed backwards and uses the updated calibration coefficients from launch to current date.

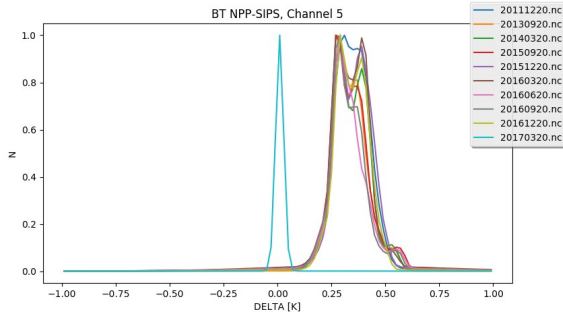


Figure 1: Differences of Sounder SIPS ATMS-V2 and IDPS for different years.

To underline this further we provide a comparison of IDPS to the now obsolete Sounder SIPS ATMS-V1, when the NASA algorithm also used the erroneous coefficients. The data shows two days of 2016 in Fig. 2, before the correction of the error in the coefficients: IDPS and the previous Sounder SIPS ATMS-V1 agree very well here, similar to the comparison of Sounder SIPS ATMS-V2 and IDPS-newCoeff.

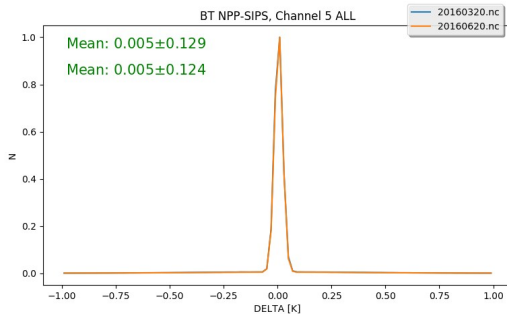


Figure 2: Differences of Sounder SIPS ATMS-V1 and IDPS for days before the change of coefficients

The Appendix shows all 22 channels for the same dates as seen in Fig. 1. All figures show the same behavior: drastic changes after in March 2017. However, the plots show obviously different magnitudes of the impact and therefore channel dependent behavior. However, the change of the coefficients in the quadratic correction is not only channel dependent, but also scene-brightness-dependent. An example of scene-dependence is shown in Fig. 3, which subdivides the data into polar (North and South) and non-polar. It can be seen that especially surface channels are strongly affected by the influence of the coefficient correction.

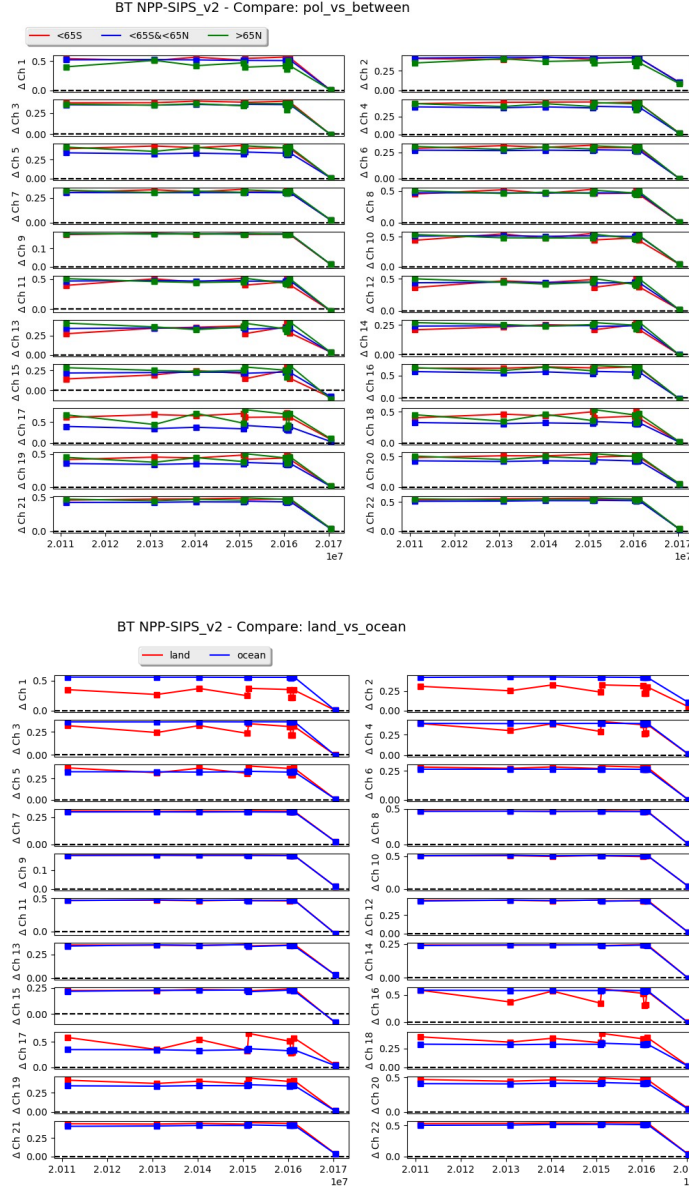


Figure 3: Differences between Sounder SIPS ATMS-V2 and IDPS for specific days between 2011 and 2017 - for different kinds of observed brightness temperatures: upper panel: polar and midlatitude , lower panel: land vs ocean

The dependence in the scene brightness temperature is non-linear, as can be seen in Fig. 4. Red contours signify data before March 2017, blue is March 2017: One can see the scene-dependent curve for the old data (red) and the nearly perfect matchup afterwards (blue), when both datasets use the updated coefficients. This is an error that cannot be corrected by a simple linear correction and highlights the need for reprocessing of the data. The other channels can be found in the Appendix.

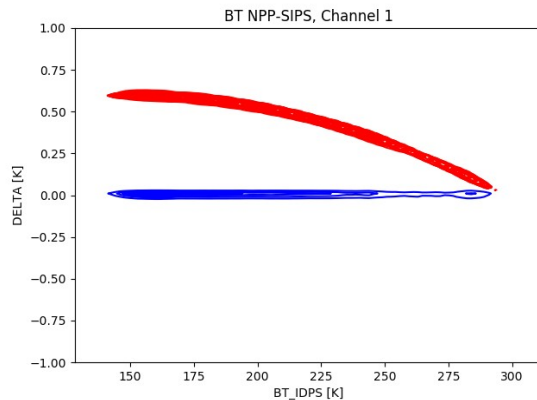


Figure 4: Differences in between Sounder SIPS ATMS-V2 and IDPS and dependence on scene temperature; red is before and blue is after the coefficient channel correction

2.2 Scene Difference

Another minor difference between NOAA and NASA algorithms is the choice of calibration weighting functions. The details are described in the ATMS ATBD [1], so here we will only describe the principle: To calibrate a scan line, the hot and cold target-counts are each averaged over several scan lines. The averaging is dependent on a weighting function. NASA and NOAA use slightly different weighting functions: IDPS applies a channel dependent box function, averaging 5-10 scan lines. Some changes were introduced during the mission to avoid “striping”, mainly during the beginning of the mission. NASA is also using a channel dependent box function between 5 and 9 scans, but uses the same function for the entire mission timeline.

The differences between IDPS and Sounder SIPS ATMS-V1 are not significant but are visible. Fig. 5 shows a sample scene, where we subtracted Sounder SIPS ATMS-V1 from IDPS-oldCoeff. This means, both versions are using the old coefficients and are calculating the calibration in brightness space. We use channel 2, which is very sensitive to tropospheric fluctuations and surface changes. We see a visible striping in this figure, which is resulting from the differences of averaging with the box functions. As the box functions are slightly different, they can have different start and ending points. However, the impact is statistically random and on average we have only small differences $\ll 0.1\text{K}$. However, things change after the update.

A comparison of Sounder SIPS ATMS-V2 with IDPS-radbased is shown in Fig. 6. The scene is taken from files after the update on 08-MAR-2017. The overall picture is still showing random striping, based on the variation in the use of box functions. However, we can also distinguish a pattern, which seems to be correlated to a tropospheric weather pattern. The difference is therefore obviously dependent on the scene temperature. Both codes have updated coefficients in this case, so it is no artifact of the quadratic coefficient problem. However, as was noted before, IDPS was also changing the way to do calibration after 08-MAR-2017: The IDPS code was changed to do calibration in

radiance space, and not in brightness temperatures. This is another change in the IDPS-data, which disturbs the continuity of the data. Also, both changes in the IDPS code – coefficient correction and change to calibration in radiance space – seem to have happened on the same date. So, it is difficult to identify and clarify what is the source of the deviation. To understand this, we have to understand the new IDPS code changes and how it impacts the comparison. We will discuss the reasons for the differences shortly in the following chapter.

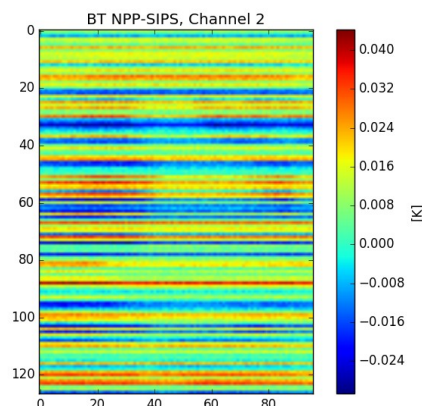


Figure 5: Differences of a random scene of Sounder SIPS ATMS-V1 and IDPS-oldCoeff

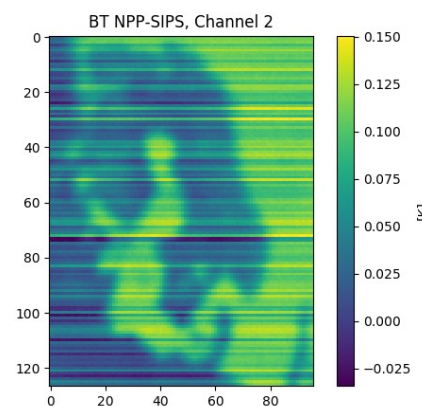


Figure 6: Differences of a random scene of Sounder SIPS ATMS-V2 and IDPS-radbased.

2.3 Differences in Brightness Temperature and Radiance Calibration

To understand the difference in Fig 6 we had to look into the IDPS code itself. The changes happened obviously after IDPS changed to calibration in radiance space. But there were several factors that could impact these results, like changes in the quadratic coefficients or radiance-conversions, but also possible errors in cold space temperatures. To eliminate possible influences, we reconfigured the IDPS code to allow the processing of L0 data from Sounder SIPS ATMS-V2. We processed this data with different configurations and got "IDPS-like" results, which were compared to our Sounder SIPS ATMS-V1 L1 data. The analysis involved several steps, but we will not introduce more datasets. We will just focus on the main important results, as can be seen in Fig. 7: In this case, we compared the results between the new IDPS-calibration procedure (radiance) and old procedure (brightness temperature). So, the histograms show the difference between these two ways of calculation. However, we did two types of calculations: on the left plot, we turned the quadratic correction on (left), on the right side, we omitted the quadratic correction. We calculated the results one time in radiance space and one time in brightness temperature space and subtracted the differences. It shows quite clearly that the differences result from the quadratic correction and the difference in IDPS-radbased and Sounder SIPS ATMS-V2 are mainly a result of slight differences in the quadratic coefficients. The other influences (conversion, cold space, box functions) have only a minor impact compared to the impact of the quadratic correction.

Our assumption is that the conversion of the quadratic correction into radiance space might have resulted in small errors: The original coefficients by Northrop-Grumman, which are also used by Sounder SIPS ATMS-V2, are calculated in brightness temperature space. We are unaware, who converted these factors into radiance space, because it was done by IDPS. However, based on these results, we consider the brightness temperatures method less error prone. However, we also want to point out that these differences are minor and channel dependent. The remaining variation for the other channels can be seen in the Appendix.

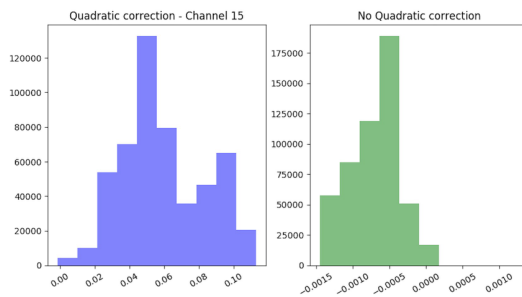


Figure 7: Calculations with a modified IDPS code, which allows a comparison of the new calibration procedure (radiance) and old procedure (brightness temperature). The left side shows the differences between new and old procedure WITH quadratic correction, right side shows without correction (y-scale is enhanced in this plot). The remaining channels can be found in the Appendix

2.4 Moon Angles

Another significant difference to IDPS and NASA is the handling of moon intrusion during cold space observations. Both in Sounder SIPS ATMS-V1 and V2, all data that may be affected by moon intrusion is flagged erroneous. The error flagging is based on algorithm calculations from a standard geolocation package that is used for NASA orbital calculations. The data is not discarded, but marked with an error flag. The calibration is handled differently during lunar intrusion: as the lunar intrusion is affecting the current cold space, a reliable cold space count before the intrusion is used for calibration. This allows processing data of earth observations even during the intrusion. However, the reliability is decreasing with the length of intrusion. So, dependent on the time frame of the lunar intrusion, the data is flagged with increasing error flags, which are described in the NASA NETCDF-file. The data is processed but always flagged with an error, which allows the users to decide on a later point how far they want to trust the data and how to handle it.

Sounder SIPS ATMS-V1 used a "save" configuration, where all channels were flagged as erroneous, if the moon intrusion was within 4 degrees. Analysis of the L1 data showed, that channel 1 and 2 were actually affected for angles > 4 degrees, whereas it was a very conservative estimate for high frequency channels. This resulted in late flagging of data from channels 1 and 2, but a very conservative error flagging of good data in channel 3 and higher, because these channels showed no sign of impact from the lunar intrusion at 4 degrees.

For Sounder SIPS ATMS-V2, we decided therefore to provide a channel dependent flagging of the data. Based on ~40,000 granules with lunar intrusions from 2012 to 2017, we developed a study to estimate the lunar intrusion for different channels. Examples of the study are shown in Fig. 8. It is very obvious, that the lunar intrusion is strongly channel dependent and also statistically noisy, even with 5 years of observations.

The final results are:

- CHANNEL 1- 1 : 7.4
- CHANNEL 3-9 : 3.8
- CHANNEL 10-16: 3.2
- CHANNEL 17-22: 2.4

The channels are clustered in four groups to keep the variation to a minimum. However, it also allows for example the use of data from channels 17-22, when Channel 1 is suffering from lunar contamination. It also reduces the duration for higher channels when lunar intrusion might affect the calibration calculation. Our plan is to verify and update this table to ensure constant refinement to upcoming versions.

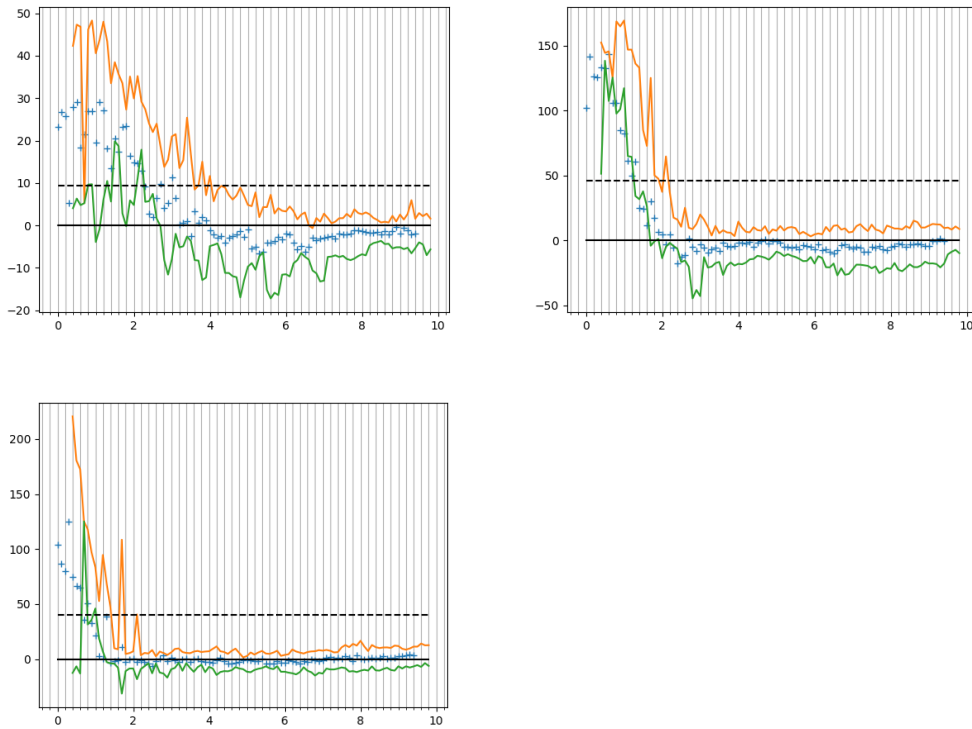


Figure 8: *The impact of lunar intrusion on the cold space calibration factor, shown for channel 1(upper left), 12 (upper right) and 17 (lower left).*

2.5 Geolocation

The geolocation of Sounder SIPS ATMS-V1 with respect to Latitude and Longitude is based on telemetry and was overlapping with IDPS to 100%. No changes were made for V2. The geolocation can only be verified to a certain degree due to the resolution of the footprints. However to show the good accuracy of the telemetry and algorithms, we show the assessment of ATMS on JPSS-1 here. We note that ATMS on JPSS-1 was put into stare mode during on-orbit checkout, and the analysis of coastline crossings makes it possible to determine actual pointing to a high degree of accuracy. A separate report will discuss the results of that analysis, but a brief overview is provided below.

2.5.1 Geolocation Errors (based on ATMS on JPSS-1)

The following section is only an addendum, based on data from ATMS on JPSS-1. Due to the lack of stare mode operations with ATMS on SNPP, we have no option to do this analysis for SNPP at the moment of writing. However, the algorithms to process geolocation are similar, so we considered it worth while to put it as a short addendum to this assessment. These preliminary calculations are only based on data from Channel 1, but they verify the good accuracy of the geolocation of the data.

The stare mode of ATMS creates an array of very narrow observations (~ 0.01 km) in one specific direction. The stare mode was hereby used during several coastal overpasses, where land fraction is changing from 0 to 1 (or vice versa). The broad spatial response functions of the ATMS-antennas result in a "smeared" observation of the coastal region. This results in a slow increase (or decrease) of observational counts. The observed change in counts from ATMS during the stare mode can therefore be compared to the calculated land fraction, which is based on given lat/lon information. In an idealized case, the measured counts from ATMS will have a saddle point, when land fraction is changing from 0 to 1.

The basic idea for this analysis is therefore:

The location of the saddle point should overlap with the change of land fraction. Any deviation of saddle point and land fraction = 0.5 would be deviation of the geolocation. We looked for this saddle point with a variety of mathematical derivations and smoothing processes.

The current results are summarized in Fig 9. By using all usable datasets and all mathematical approaches, we find a very good agreement.

The main result (All) is a deviation of 1.1 km to the North (0.08 rad). The results are promising, especially, when taking into account the STDDEV of 10.57. The result is shown as a black circle in Fig 10, showing only a slight deviation from the center point.

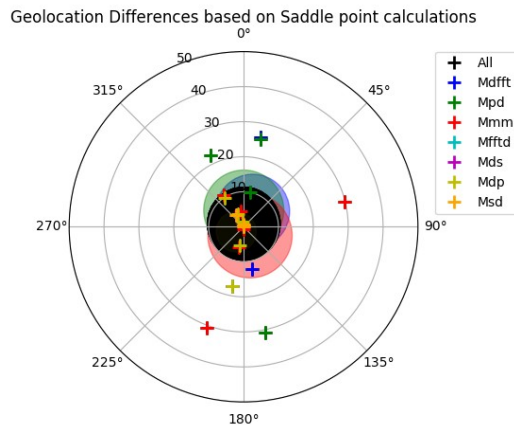


Figure 9: Summary of the geolocation analysis for Channel 1.

3. Conclusion

This document describes the assessment of Suomi NPP ATMS Level 1B Brightness Temperature V2 (SNPPATMSL1B V2), based on a code developed by SIPS at JPL. Version 2 has two major changes compared to V1:

- The brightness temperatures are more correct due to updated quadratic coefficients.
- The error flags for the lunar intrusion are now updated

The update for the lunar intrusion makes it easier to filter possible contaminated data, if in doubt: It is now channel specific and these angles are based on analyzed data of moon intrusions during the mission. This update has no strong impact on the brightness temperatures, but it helps to reduce the amount of data flagged as erroneous, and also helps to understand the lunar intrusion better. It also shortens the gaps of error flagging for most channels.

The update with respect to the quadratic correction is an improvement and the main reason for the reprocessing of all data since launch in 2011. It corrects errors in the brightness temperatures with a magnitude of 0.5 – 1.5 K, which is channel dependent and also scene temperature dependent. The reprocessing allows continuity of the data for the entire mission and is improvement for the entire dataset. Users who downloaded V1 should replace it with the new V2. Users should also be aware that this creates a conflict with respect to comparisons with the IDPS ATMS TDR: According to the documentation, IDPS updated the coefficients in the code on May 28th 2015. But the change in processed data with the new coefficients did not start before March 2017 on NOAA CLASS. Also, there was no reprocessing of older data for NOAA, which means there is a jump in the continuity.

The reprocessing of NASA data on the other hand makes this update available for all ATMS data since the beginning of the mission.

As a result, we have now bigger differences to the files from IDPS processing, which are available on NOAA CLASS: SNPPATMSL1B V1 was very close to IDPS processed data, but both had wrong quadratic corrections. NASA V2 is updated for the entire mission, whereas NOAA CLASS data was updated in March 2017 without reprocessing of older data. SNPPATMSL1B V2 deviates therefore from IDPS TDR before this date and aligns again after this date.

We also found a slight deviation from the IDPS software with respect to scene temperature. This is a result of additional changes in the IDPS code: IDPS did not only update the coefficients during the update in March 2017, but also changed the calibration procedure: it is now in radiance space instead of brightness temperature space. This results in a slight scene temperature dependent deviation between SNPPATMSL1B V2 and IDPS processed TDR. This is a result of slight differences in the quadratic correction terms, which seems to have happened during the coefficient conversion by IDPS. The use of radiance calibration is not used for SNPPATMSL1B V2 and not planned in the near future, as an improvement by using radiance calibration cannot be verified. However, the impact is usually 0.1 K and lower and might therefore be insignificant.

In general, this means that SNPPATMSL1B V2 is improved for the entire mission, whereas IDPS DR is improved only after March 2017. There are therefore no large differences between these two datasets after March 2017. However, due to the

reprocessing, we consider the SNPPATMSL1B V2 a more reliable with respect to long-term analysis and climate observations.

4. References

[1] Lambrigsten, B., “Suomi National Polar Partnership Mission Algorithm Theoretical Basis Document NASA L1b: Advanced Technology Microwave Sounder”, Version 1, July 2014.

5. Acronyms

| | |
|--------------|--|
| ATMS | Advanced Technology Microwave Sounder |
| CLASS | Comprehensive Large Array-data Stewardship System |
| DAAC | Distributed Active Archive Center |
| FOV | Field of View |
| GES DISC | Goddard Earth Science Data and Information Services Center |
| HDF | Hierarchical Data Format |
| IDPS | Interface Data Processing Segment |
| IDPS SDR/TDR | ATMS L1 product, based on the IDPS code |
| JPSS | Joint Polar Satellite System |
| netCDF | Network Common Data Form |
| NPOESS | NOAA Polar-Orbiting Operational Environmental Satellite System |
| NPP | National Polar-orbiting Partnership (formerly known as the NPOESS Preparatory Project) |
| SDR | Sensor Data Record |
| SNPP | Suomi National Polar-orbiting Partnership |
| TDR | Temperature Data Record |

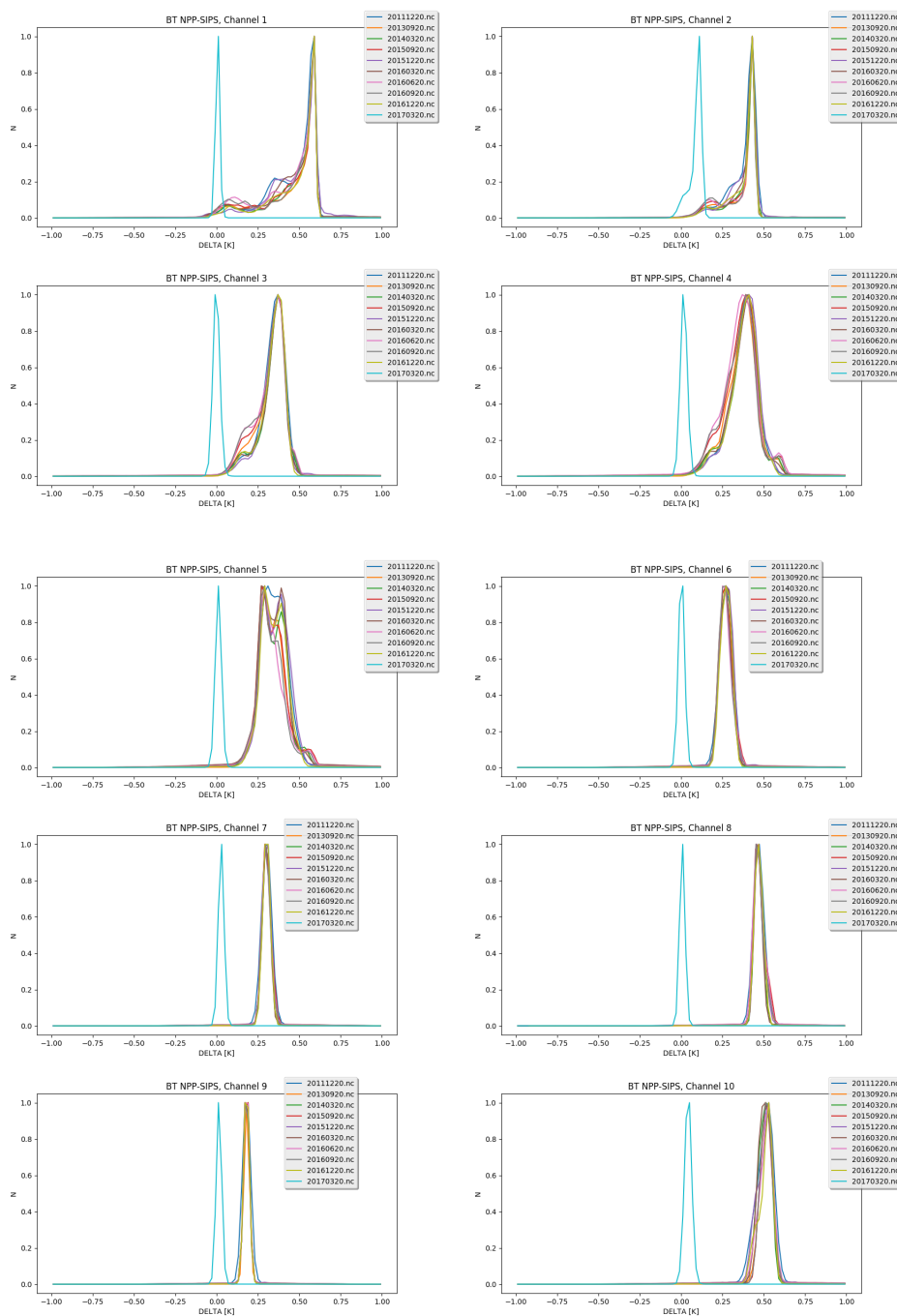
6. Addendum

6.1 Differences of Sounder SIPS ATMS-V2 and IDPS for various days of the mission

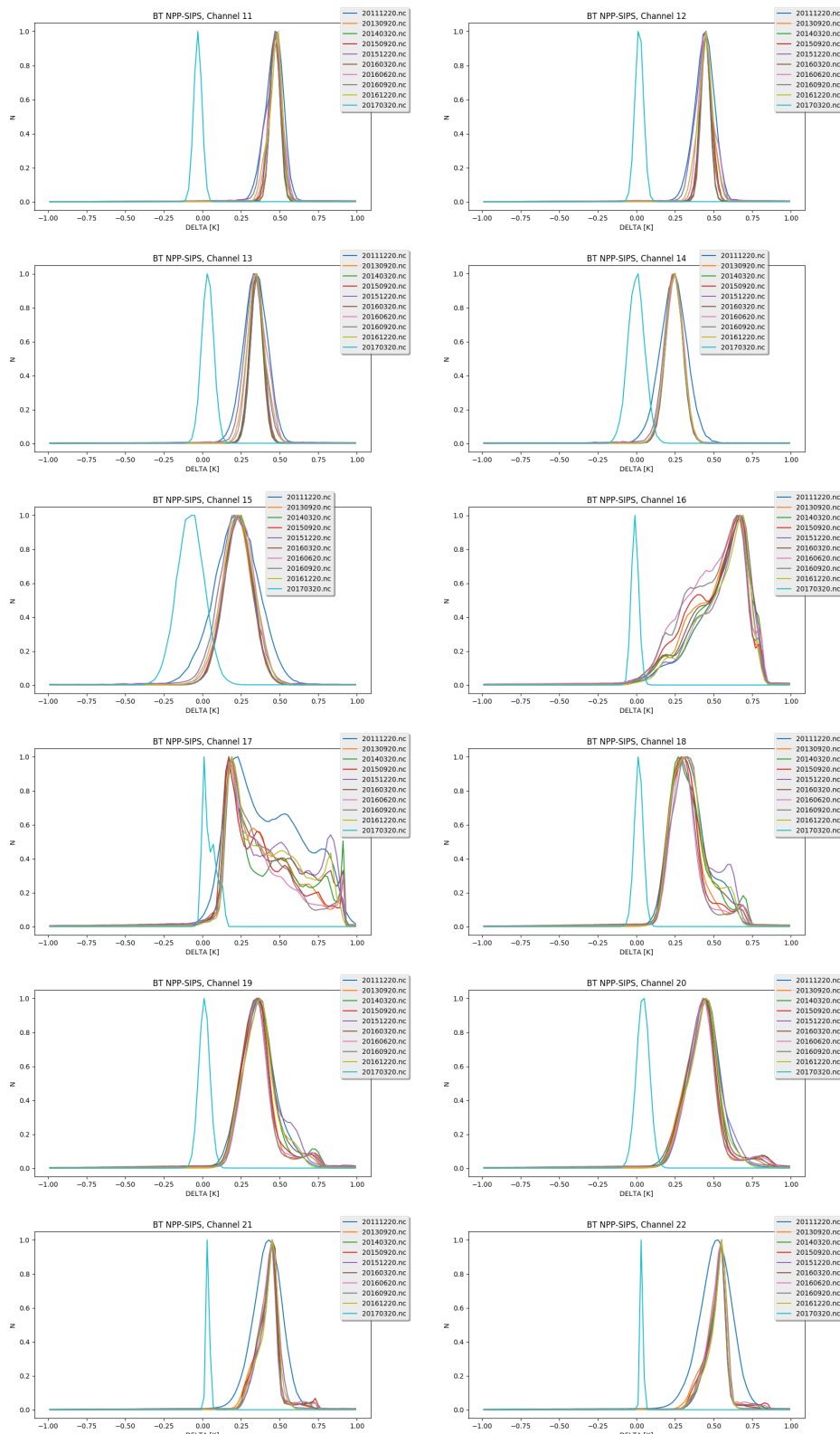
This shows the same as Fig. 1, but for all channels. Additionally to the changes in March 2017 you can also observe specific behavior for certain channels. Examples are channel 21 and 22, which show different behaviors in the early years of the mission. Several

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factors, like e.g. the averaging weighting functions, were still changed during the mission, resulting in a change of brightness temperatures compared to reprocessed NASA data. Another indicator, that NOAA CLASS data has problems with continuity of the dataset.

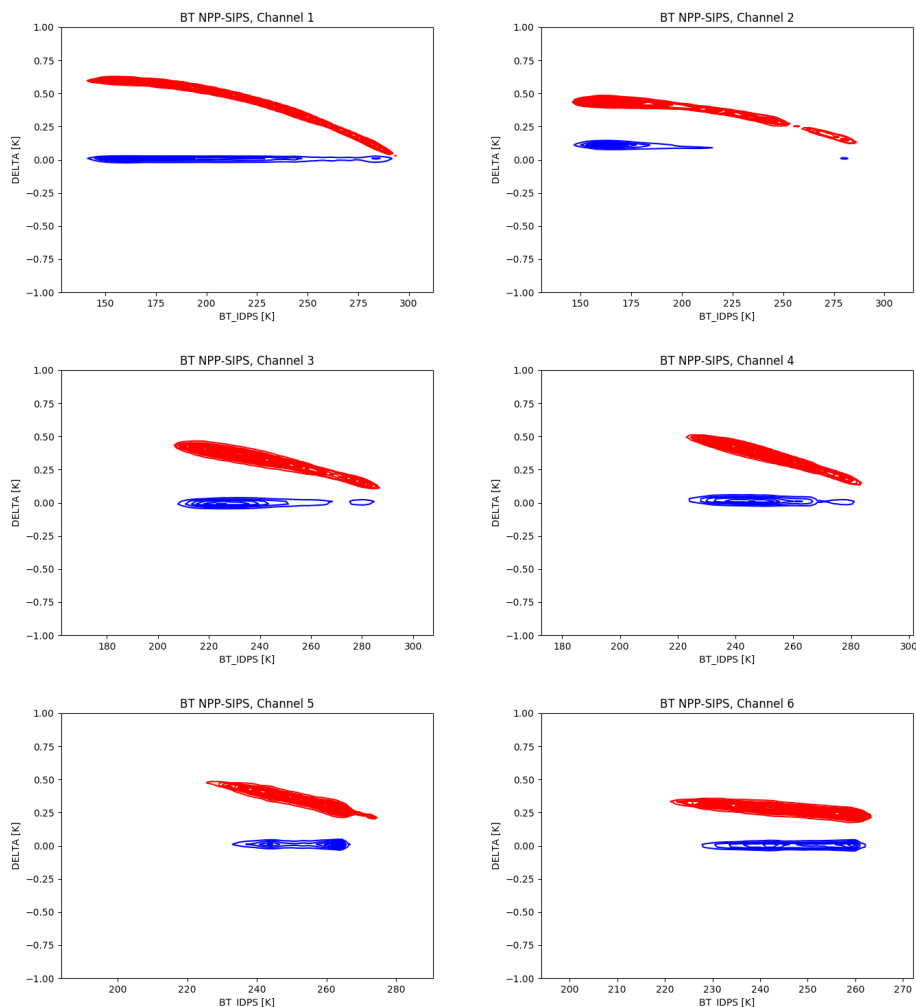


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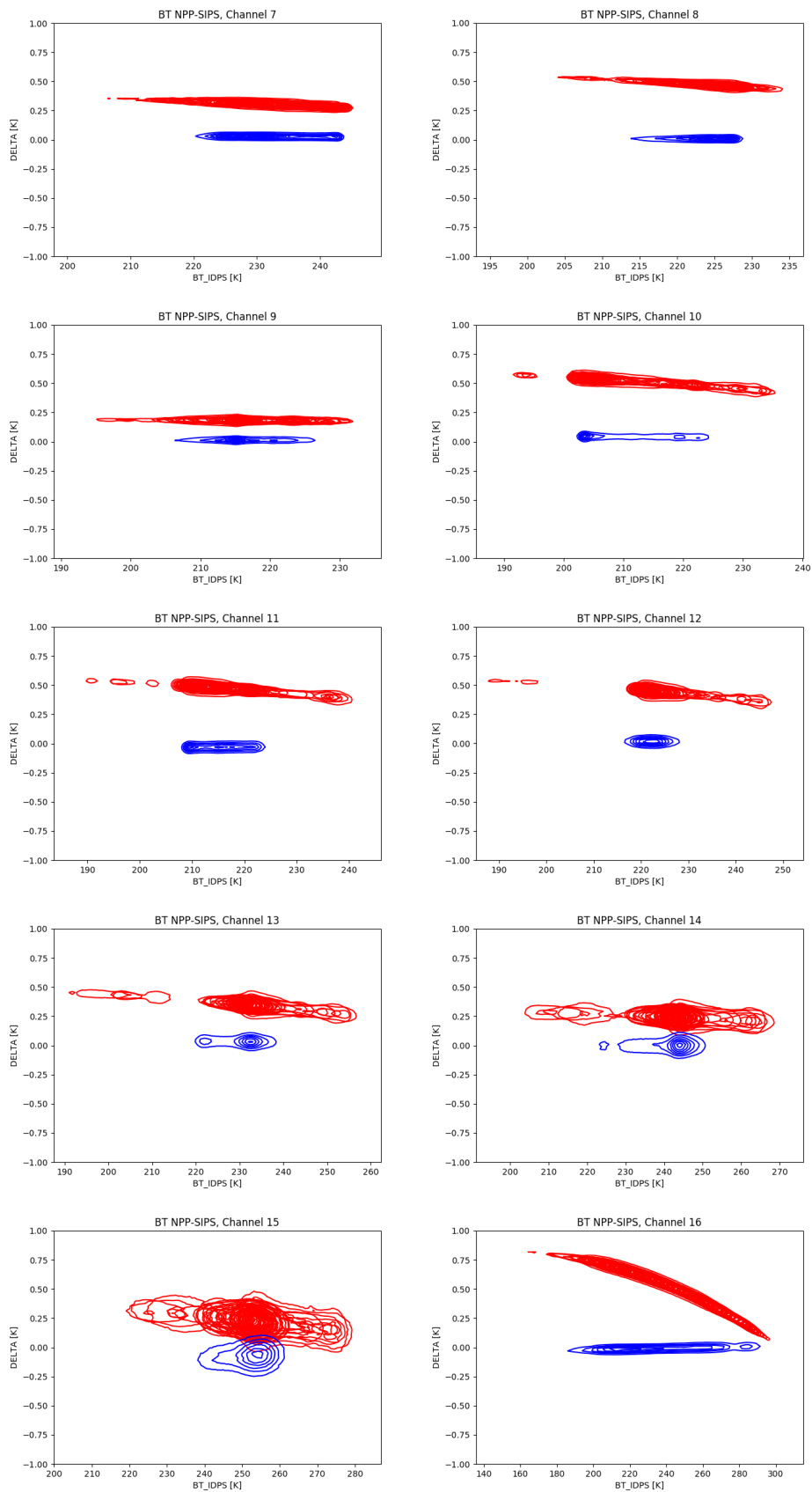


6.2 The dependence on brightness temperature

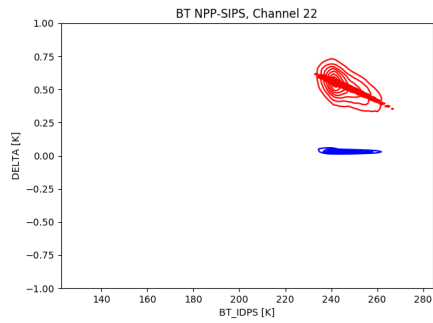
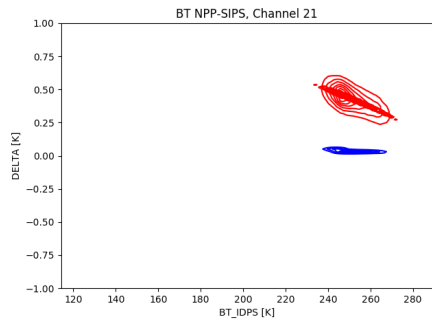
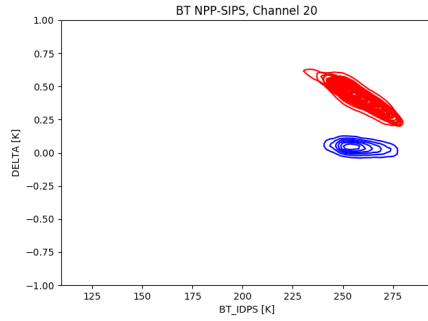
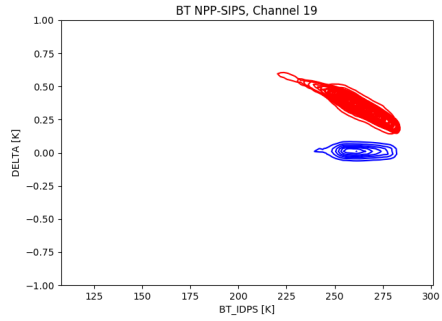
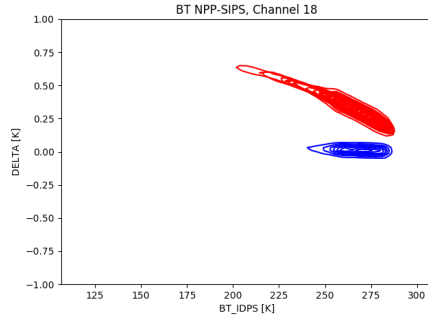
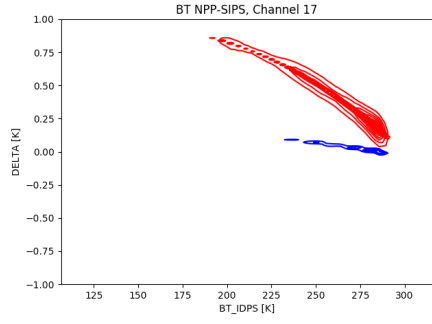
These plots are similar to Fig. 4, but are plotted for all channels. All channels show a dependence on brightness temperature and the need for reprocessing of the data. Several channels, like channel 15 also show the increase of difference between NOAA and NASA with increasing noise.



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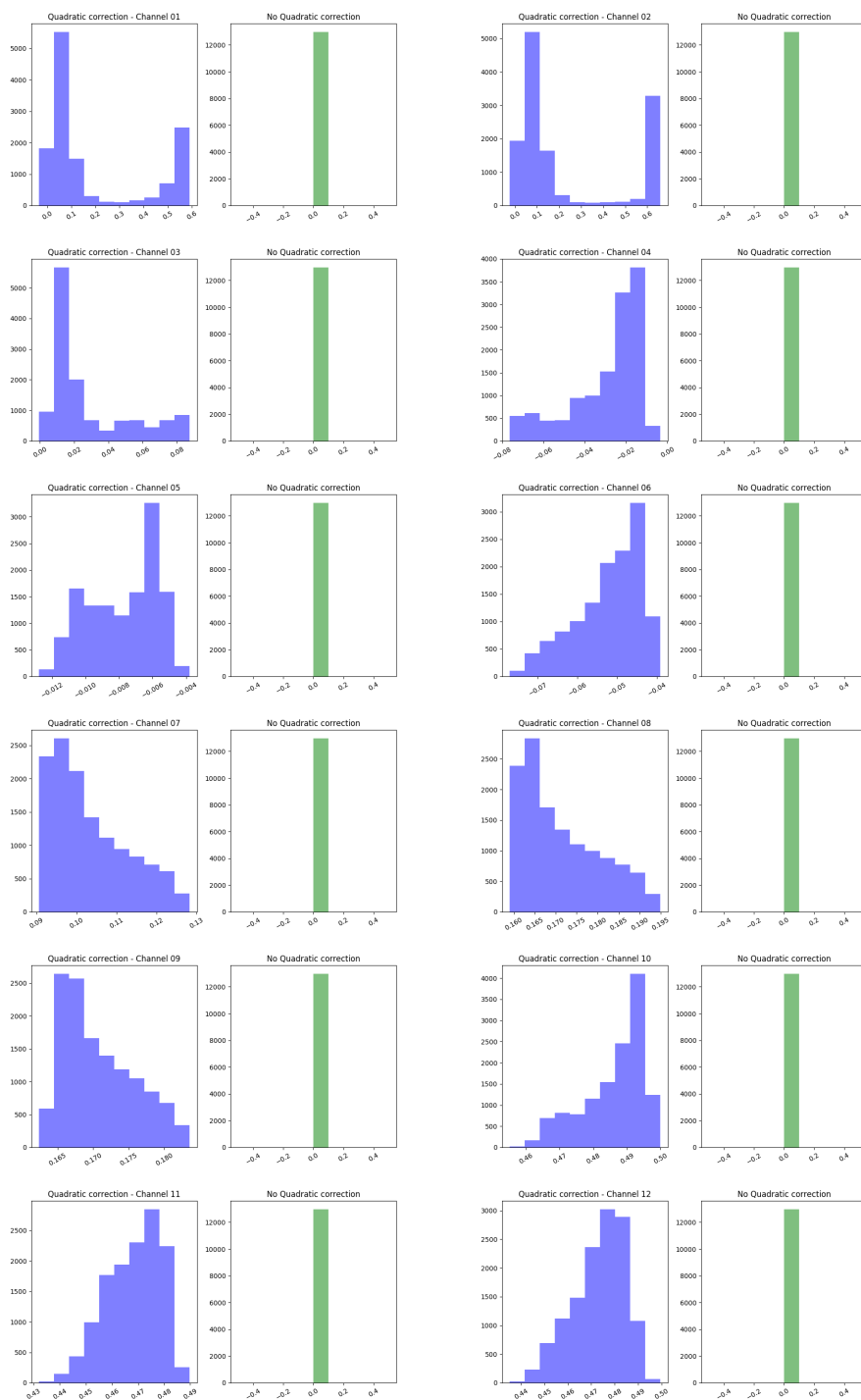


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6.3 Comparison of calibration with brightness temperatures and radiances

The plots are similar to Fig. 7, but again all channels. Obviously, all differences are a result of the different coefficients in radiance space, compared to brightness temperature space. Other factors have almost no impact or at least $\ll 0.1\text{K}$.



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